Engineering Technicians

(O*NET 22502, 22505A, 22505B, 22505C, 22508, 22511, 22599B, 22599C, 22599D, 22599E, 22599G, and 93111B)

Significant Points

- Electrical and electronic engineering technicians comprise about 43 percent of all engineering technicians.
- The type and quality of training programs vary considerably; prospective students should carefully select a program.
- Most employers prefer applicants with an associate degree in engineering technology.

Nature of the Work

Engineering technicians use the principles and theories of science, engineering, and mathematics to solve technical problems in research and development, manufacturing, sales, construction, inspection, and maintenance. Their work is more limited in scope and more practically oriented than that of scientists and engineers. Many engineering technicians assist engineers and scientists, especially in research and development. Others work in quality control—inspecting products and processes, conducting tests, or collecting data. In manufacturing, they may assist in product design, development, or production.

Engineering technicians, who work in research and development, build or set up equipment, prepare and conduct experiments, calculate or record the results, as well as help engineers in other ways. Some make prototype versions of newly designed equipment. They also assist in design work, often using computer-aided design equipment.

Engineering technicians, who work in manufacturing, support the work of engineers. They may prepare specifications for materials, devise and run tests to ensure product quality, or study ways to improve manufacturing efficiency. They may also supervise production workers to make sure they follow prescribed procedures.

Most engineering technicians specialize in certain areas, learning skills and working in the same disciplines as engineers. Occupational titles, therefore, tend to follow the same structure as engineers. *Chemical engineering technicians* are usually employed in industries producing pharmaceuticals, chemicals, and petroleum products, among others. They work in laboratories as well as processing plants. They help develop new chemical products and processes, test processing equipment and instrumentation, monitor quality, and operate chemical manufacturing facilities.

Civil engineering technicians help civil engineers plan and build highways, buildings, bridges, dams, wastewater treatment systems, and other structures, and perform related surveys and studies. Some inspect water and wastewater treatment systems to ensure pollution control requirements are met. Others estimate construction costs and specify materials to be used. Some may even prepare drawings or perform land-surveying duties. (Separate statements on cost estimators, drafters, and surveyors can be found elsewhere in the *Handbook*.)

Electrical and electronics engineering technicians help design, develop, test, and manufacture electrical and electronic equipment such as radios, radar, sonar, television, industrial and medical measuring or control devices, navigational equipment, and computers. They may work in product evaluation and testing, using measuring and diagnostic devices to adjust, test, and repair equipment. Workers who only repair electrical and electronic equipment are discussed in several other statements on mechanics, installers, and repairers found elsewhere in the *Handbook*. Many of these repairers are often referred to as electronics technicians.

Electrical and electronic engineering technology is also applied to a wide variety of systems such as communications and process controls. *Electromechanical engineering technicians* combine fundamental principles of mechanical engineering technology with knowledge of electrical and electronic circuits to design, develop, test, and manufacture electrical and computer controlled mechanical systems.

Industrial engineering technicians study the efficient use of personnel, materials, and machines in factories, stores, repair shops, and offices. They prepare layouts of machinery and equipment, plan the flow of work, make statistical studies, and analyze production costs.

Mechanical engineering technicians help engineers design, develop, test, and manufacture industrial machinery, mechanical parts, and other equipment. They may assist in testing a guided missile or planning and designing an electric power generation plant. They make sketches and rough layouts, record data, make computations, analyze results, and write reports. When planning production, mechanical engineering technicians prepare layouts and drawings of the assembly process and of parts to be manufactured. They estimate labor costs, equipment life, and plant space. Some test and inspect machines and equipment in manufacturing departments or work with engineers to eliminate production problems.

Working Conditions

Most engineering technicians work at least 40 hours a week in laboratories, offices, manufacturing or industrial plants, or on construction sites. Some may be exposed to hazards from equipment, chemicals, or toxic materials.

Employment

Engineering technicians held about 771,000 jobs in 1998. About 335,000 of these were electrical and electronics engineering technicians. About 30 percent of all engineering technicians worked in durable goods manufacturing, mainly in the electrical and electronic machinery and equipment, industrial machinery and equipment, instruments and related products, and transportation equipment industries. Another 30 percent worked in service industries, mostly in engineering or business services companies that do engineering work on contract for government, manufacturing, or other organizations.

Engineering technicians use computer-aided equipment to devise and run tests to ensure product quality.

In 1998, the Federal Government employed about 39,000 engineering technicians. The major employer was the Department of Defense, followed by the Departments of Transportation, Agriculture, and Interior, the Tennessee Valley Authority, and the National Aeronautics and Space Administration. State governments employed about 30,000, and local governments about 26,000.

Training, Other Qualifications, and Advancement

Although it may be possible to qualify for a few engineering technician jobs without formal training, most employers prefer to hire someone with at least a 2-year associate degree in engineering technology. Training is available at technical institutes, community colleges, extension divisions of colleges and universities, public and private vocational-technical schools, and through some technical training programs in the Armed Forces. Persons with college courses in science, engineering, and mathematics may qualify for some positions but may need additional specialized training and experience. Although engineering technicians usually are not required to be certified by employers, such certification may provide jobseekers a competitive advantage.

Prospective engineering technicians should take as many high school science and math courses as possible to prepare for postsecondary programs in engineering technology. Most 2-year associate degree programs accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC/ABET) require, at a minimum, college algebra and trigonometry, and one or two basic science courses. Depending on the specialty, more math or science may be required.

The type of technical courses required also depends on the specialty. For example, prospective mechanical engineering technicians may take courses in fluid mechanics, thermodynamics, and mechanical design; electrical engineering technicians may take classes in electric circuits, microprocessors, and digital electronics; and those preparing to work in environmental engineering technology need courses in environmental regulations and safe handling of hazardous materials.

Because many engineering technicians may assist in design work, creativity is desirable. Good communication skills and the ability to work well with others is also important since they are often part of a team of engineers and other technicians.

Engineering technicians usually begin by performing routine duties under the close supervision of an experienced technician, technologist, engineer, or scientist. As they gain experience, they are given more difficult assignments with only general supervision. Some engineering technicians eventually become supervisors.

Many publicly and privately operated schools provide technical training; the type and quality of programs vary considerably. Therefore, prospective students should be careful in selecting a program. They should contact prospective employers regarding their preferences and ask schools to provide information about the kinds of jobs obtained by graduates, instructional facilities and equipment, and faculty qualifications. Graduates of ABET-accredited programs are usually recognized to have achieved an acceptable level of competence in the mathematics, science, and technical courses required for this occupation.

Technical institutes offer intensive technical training, but less theory and general education than community colleges. Many offer 2-year associate degree programs, and are similar to or part of a community college or State university system. Other technical institutes are run by private, often for-profit, organizations, sometimes called proprietary schools. Their programs vary considerably in length and types of courses offered, although some are 2-year associate degree programs.

Community colleges offer curriculums similar to those in technical institutes but may include more theory and liberal arts. Often there may be little or no difference between technical institute and community college programs, as both offer associate degrees. After completing the 2-year program, some graduates get jobs as engineering technicians, while others continue their education at 4-year colleges. However, there is a difference between an associate degree in pre-engineering and one in engineering technology. Students who enroll in a 2-year pre-engineering program may find it very difficult to find work as an engineering technician should they decide not to enter a 4-year engineering program, because pre-engineering programs usually focus less on hands-on applications and more on academic preparatory work. Conversely, graduates of 2-year engineering technology programs may not receive credit for many of the courses they have taken if they choose to transfer to a 4-year engineering program. Colleges with these 4-year programs usually do not offer engineering technician training, but college courses in science, engineering, and mathematics are useful for obtaining a job as an engineering technician. Many 4-year colleges offer bachelor's degrees in engineering technology, but graduates of these programs are often hired to work as technologists or applied engineers, not technicians.

Area vocational-technical schools include postsecondary public institutions that serve local students and emphasize training needed by local employers. Most require a high school diploma or its equivalent for admission.

Other training in technical areas may be obtained in the Armed Forces. Many military technical training programs are highly regarded by employers. However, skills acquired in military programs often are narrowly focused, so they may not be useful in civilian industry, which often requires broader training. Therefore, some additional training may be needed, depending on the acquired skills and the kind of job.

The National Institute for Certification in Engineering Technologies (NICET) has established a voluntary certification program for engineering technicians. Certification is available at various levels, each level combining a written examination in one of over 30 specialties with a certain amount of job-related experience.

Job Outlook

Opportunities will be best for individuals with an associate degree in engineering technology. As technology becomes more sophisticated, employers continue to look for technicians who are skilled in new technology and require a minimum of additional job training.

Overall employment of engineering technicians is expected to increase about as fast as the average for all occupations through 2008. As production of technical products continues to grow, competitive pressures will force companies to improve and update manufacturing facilities and product designs more rapidly than in the past. However, the growing availability and use of advanced technologies, such as computer-aided design and drafting and computer simulation, will continue to increase productivity and limit job growth. In addition to growth, many job openings will be created to replace technicians who retire or leave the labor force.

Like engineers, employment of engineering technicians is influenced by local and national economic conditions. As a result, the employment outlook varies with industry and specialization. Employment of some types of engineering technicians, such as civil engineering and aeronautical engineering technicians, experience greater cyclical fluctuations than others. Increasing demand for more sophisticated electrical and electronic products, as well as the expansion of these products and systems into all areas of industry and manufacturing processes, will contribute to average growth in the largest specialty—electrical and electronics engineering technicians. At the same time, new specializations will contribute to growth among all other engineering technicians. Fire protection engineering technology, for example, is one of many new specialties for which demand is increasing.

Earnings

Median annual earnings of electrical and electronics engineering technicians were $35,970 in 1998. The middle 50 percent earned

between $27,680 and $45,750. The lowest 10 percent earned less than $21,710 and the highest 10 percent earned more than $62,540. Median annual earnings in the industries employing the largest numbers of engineering technicians in 1997 are shown below:

Engineering and architectural services	$36,600
Computer and data processing services	33,600
Computer and office equipment	33,000
Electrical components and accessories	32,100
Personnel supply services	25,400

Median annual earnings of all other engineering technicians and technologists in 1998 were $37,310. The middle 50 percent earned between $28,510 and $47,610. The lowest 10 percent earned less than $22,230 and the highest 10 percent earned more than $68,720. Median annual earnings in the industries employing the largest numbers of other engineering technicians and technologists in 1997 are shown below:

Federal Government	$42,700
Electrical components and accessories	33,500
Engineering and architectural services	32,600
Local government	32,200
State government	27,500

In the Federal Government, engineering technicians started at about $18,600, $21,200, or $25,000 in early 1999, depending on their education and experience. Beginning salaries were slightly higher in selected areas of the country where the prevailing local pay level was higher.

Related Occupations

Engineering technicians apply scientific and engineering principles usually acquired in postsecondary programs below the baccalaureate level. Similar occupations include science technicians, drafters, surveyors, broadcast and sound technicians, and health technologists and technicians.

Sources of Additional Information

For a small fee, information on a variety of engineering technician and technology careers is available from:

☛ The Junior Engineering Technical Society (JETS), at 1420 King St., Suite 405, Alexandria, VA 22314-2794. Enclose $3.50 to obtain a full package of guidance materials and information. Brochures are available free on JETS Internet site: **http://www.jets.org**

Information on ABET-accredited engineering technology programs is available from:

☛ Accreditation Board for Engineering and Technology, Inc. 111 Market Place, Suite 1050, Baltimore, MD 21202. Internet: **http://www.abet. org**

Architects, Surveyors, and Drafters

Architects, Except Landscape and Naval

(O*NET 22302)

Significant Points

- About 30 percent were self-employed—over three times the proportion for all professionals.
- Licensing requirements include a professional degree in architecture, a period of practical training or internship, and passing all divisions of the Architect Registration Examination.
- Beginners may face competition, especially for jobs in the most prestigious firms; summer internship experience and knowledge of computer-aided design and drafting technology are advantages.

Nature of the Work

Architects design buildings and other structures. The design of a building involves far more than its appearance. Buildings must also be functional, safe, and economical, and must suit the needs of the people who use them. Architects take all these things into consideration when they design buildings and other structures.

Architects provide professional services to individuals and organizations planning a construction project. They may be involved in all phases of development, from the initial discussion with the client through the entire construction process. Their duties require specific skills—designing, engineering, managing, supervising, and communicating with clients and builders.

The architect and client discuss the objectives, requirements, and budget of a project. In some cases, architects provide various predesign services—conducting feasibility and environmental impact studies, selecting a site, or specifying the requirements the design must meet. For example, they may determine space requirements by researching the number and type of potential users of a building. The architect then prepares drawings and a report presenting ideas for the client to review.

After the initial proposals are discussed and accepted, architects develop final construction plans. These plans show the building's appearance and details for its construction. Accompanying these are drawings of the structural system; air-conditioning, heating, and ventilating systems; electrical systems; plumbing; and possibly site and landscape plans. They also specify the building materials and, in some cases, the interior furnishings. In developing designs, architects follow building codes, zoning laws, fire regulations, and other ordinances, such as those requiring easy access by disabled persons. Throughout the planning stage, they make necessary changes. Although they have traditionally used pencil and paper to produce design and construction drawings, architects are increasingly turning to computer-aided design and drafting (CADD) technology for these important tasks.

Architects may also assist the client in obtaining construction bids, selecting a contractor, and negotiating the construction contract. As construction proceeds, they may visit the building site to ensure the contractor is following the design, adhering to the schedule, using the specified materials, and meeting quality work standards. The job is not complete until all construction is finished, required tests are made, and construction costs are paid. Sometimes, architects also provide postconstruction services, such as facilities management. They advise on energy efficiency measures, evaluate how well the building design adapts to the needs of occupants, and make necessary improvements.

Architects design a wide variety of buildings, such as office and apartment buildings, schools, churches, factories, hospitals, houses, and airport terminals. They also design complexes such as urban centers, college campuses, industrial parks, and entire communities. They may also advise on the selection of building sites, prepare cost analysis and land-use studies, and do long-range planning for land development.

Architects sometimes specialize in one phase of work. Some specialize in the design of one type of building—for example, hospitals, schools, or housing. Others focus on planning and predesign